TG1-364

THE INTERNATIONAL PASSAMAQUODDY TIDAL POWER PROJECT AND THE UPPER SAINT JOHN RIVER HYDROELECTRIC POWER DEVELOPMENT

Progress Report of U. S. Army Engineer Division, New England to the

JOINT ARMY - INTERIOR PASSAMAQUODDY BOARD
November 21, 1963

LOCATION OF DICKEY DAM

Pursuant to general instructions received early in August 1963, drilling operations were started immediately at Dickey along the axis of the proposed dam. The results of the first series of holes showed the floor of the broad valley to be silt, clay, and some sand and gravel to depths of over 200 feet. The hills on the right side of the valley rise to over 300 feet above the valley and suitable rock was found near the surface. However, the hills on the left abutment, which rise over 600 feet above the valley, are principally of sand and gravel with glacial till and rock at great depths, even though there are rock outcrops near the top of some of the lines of hills paralleling the river. The foundation conditions indicated a large earth embankment with a very extensive impervious blanket would be required on the upstream side of the left abutment. Also the powerhouse intake and spillway structures would be squeezed on the right abutment. No rock was available where the powerhouse would be located. The discharge channel from both the spillway and the powerhouse would be across the plain of the valley and would require lining. Suitable rock for a diversion tunnel was found on the right bank near and below the spillway and powerhouse. This condition is shown on the drawings AD4-007, AD4-008, AD4-009, AD4-010.

In view of the foundation conditions at the site of the dam at Dickey, it became necessary to seek a more favorable dam site within the limits set out in the Department of Interior report. These are the maximum use of drainage in the Saint John River above the confluence of the Allagash River and the preservation of the historic canoe trip down the Allagash River to the confluence with the Saint John. Therefore, the dam itself must be above the Allagash River and below the inflow from the Little Black River just above the town of Dickey. Field reconnaissance indicated a possible site about 1-3/8 miles below the indicated site at Dickey. The centerline of the proposed dam crosses from the left bank of the Saint John River to Kelly School where a rocky knob rises to El. 900 and thence crosses a swampy valley to the right abutment. Drill holes have confirmed that the knob at Kelly School is rock and there is rock between the top of the knob and the ox-bow of the Allagash River where the discharge from the powerhouse would run in a cut channel to the Saint John River. The flow of the Allagash would be cut into a new channel, eliminating the oxbow. The spillway is located in a high valley at the far right abutment and discharges into the Allagash at the cut near its mouth. The drilling indicates that good till overlays rock in the valley for the spillway and the large, swampy valley behind Kelly School. Rock is deep at the right bank of the Saint John River and at the left abutment. However, good till is reasonably close to the surface and the depth of sand and gravel is much less than at the Dickey site. Consequently a smaller upstream impervious blanket will be required. The till is a suitable foundation for an earth dam.

Subsurface investigations at all saddle dams indicate suitable foundation material for earth embankments. Materials are available locally for saddle dams and the dam at Kelly School. The till will be satisfactory for impervious embankment and may be obtained in the vicinity of Dickey. Pervious material is available in quantity in terraces on the left bank of the Saint John River. It is expected that concrete aggregate and rock for riprap will be hauled about twenty-five miles from DeBouille Mountain.

The most favorable layout for the dam on the Upper Saint John River is at the Kelly School site. It is less expensive than any variation of the Dickey site and provides suitable foundations. A tentative layout is shown on Drawing AD2-239. The top of the dam is at El. 925, which is 15 feet above maximum pool elevation. The drawdown is 30 feet. With maximum pool at 910, the reservoir extends into Canada at three points, one on the Little Black River and two on the Big Black River where the Shields Brook Branch will be flooded for about $7\frac{1}{2}$ miles and be 45 feet deep at the International Boundary. Cost of relocation of three roads and bridges in Canada is a project cost and yearly taxes paid for flooded lands are an annual cost. At El. 910 five saddle dams are required. The largest is at Falls Brook with height of dam approximately 150 feet.

The Kelly School layout shows an overflow spillway of 500-foot crest length. Two 24-foot diameter lined tunnels would be used for diversion during construction and also as low level outlets after completion of construction. The powerhouse would be set into a rock-cut channel to shorten the length of penstocks. Similarly, the intake structure for the eight penstocks has been located about 200 feet downstream of the crest of the dam. The powerhouse would have 8-95,000 kw generators with Francis turbines. Generally the powerhouse is an adaptation of the one at Rankin Rapids as proposed in the International Joint Commission Report. The reregulating dam at Lincoln School is being developed similar to the one in Appendix #12 of the I. J. C. Report.

A flood control benefit would be obtained from the dam at Kelly School. The operation of the outlet works can be coordinated with river flow to largely reduce peak flows downstream. A benefit figure will be developed for the current report.

PERTINENT DATA

Kelly School Hydroplant

Streamflow

Av annual runoff, ac-ft	(Oct 1929-Sep 1960)	3,331,000
Max discharge, cfs	(May 16, 1961)	71,700
Min discharge, cfs	(Sep 12, 1948)	129
Av discharge, cfs	(Oct 1929-Sep 1960)	4,600
Dependable flow, cfs		4,100

Reservoir

Drainage area, sq mi	2,725
Max operating level, ft, msl	910
Limit of drawdown, ft, msl	880
Useable storage, ac-ft	2,300,000
Total storage, ac-ft	8,100,000
Area, max oper level, acres	88,600

PERTINENT DATA, Cont.

Kelly School Hydroplant

Main Embankment

Crest length, ft	9,900
Max height, ft	335
Crest elev	925

Spillway

Crest el, ft	910
Crest length, ft	500
Design discharge, cfs	50,000

Low Level Outlets

2 24-foot dia. tunnels controlled by 4 dispersion valves

Powerhouse

Indoor type, concrete
8 Francis type turbines with 95,000 kw generators, 13,800 volt, 3 phase, 60 cycle, 140 rpm

Lincoln School Reregulating Hydroplant

Streamflow (incremental below Kelly School)

Av annual runoff, ac-ft		1,508,000
Max discharge, cfs	(May 17, 1961)	31,400
Min discharge, cfs	(Sep 11, 1960)	95
Av discharge, cfs	(Oct 1931-Sep 1961)	2,083
Dependable flow, cfs	(equalled or exceeded 97% of time)	200

PERTINENT DATA, Cont.

Lincoln School Reregulating Hydroplant

Reservoir (below Kelly School)

Drainage area (Allagash and Kelly School), sq mi	4,086
Max oper level	605
Limit of drawdown	597
Useable storage, ac-ft	16,000
Total storage, ac-ft	52,500
Area, max oper level, acres	2,200

Main Embankment

Crest length, ft	1,250
Max height, ft	105
Crest elev	622

Spillway

4 Taintor gates	40 x 30
Crest el	575
Design discharge, cfs	150,000

Powerhouse

Indoor type, concrete
2 Kaplan type vertical axis 16,000 kw generators, 144 rpm, 13,800 volt, 3 phase, 60 cycle

SUBSURFACE INVESTIGATION, EASTPORT, MAINE

Two drill holes have explored the subsurface of the site of powerhouse No. 2 at Bar Harbor in Eastport, Maine. In addition, about 30 probes are being made in the approach and discharge channels to PH 2 to ascertain the top of rock.

LOCATION OF TIDAL PLANTS

The Department of Interior Report indicates two tidal powerhouses, each with 50-10,000 kw inclined axis Kaplan turbines and generators. One powerhouse (PH1) was located in Carryingplace Cove where the powerhouse of the IJC report was located, and the other (PH2) on the westerly peninsula of Moose Island at Bar Harbor. The layout of the tidal powerhouses is shown on drawing TP2-062.

No advantage was found in changing the location of PH2 to Carlow Island since the total excavation would be slightly increased and practically all of Carlow Island and the peninsula of Moose Island must be removed for the water channels. In addition, the highway and railroad relocation across the powerhouse would require more consideration at Carlow Island.

The approach and discharge channels to the tidal powerhouses are based on passing the total maximum turbine discharge of 650,000 cfs at a velocity not exceeding 5 feet per second. The channels are the width of the outside power units, with side slopes of $1\frac{1}{2}$ to 1 except in rock where the slope is 1 to 1. The channel widths and depths vary so as to maintain approximately a constant cross sectional area with a minimum excavation. (The total excavation for PH1 is about 35 million cubic yards and for PH2 about 55 million cubic yards).

TIDAL POWERHOUSE UNITS

The overall size of the powerhouse and its output depend upon the size and type of water wheel and generator approved for each power unit block. The Department of Interior report showed an inclined axis Kaplan turbine with a direct connected generator. The unit was proposed by the Allis-Chalmers Manufacturing Company. As the result of a meeting in Denver at the Bureau of Reclamation on September 5, 1963 which was attended by representatives of the Chief of Engineers and the Allis-Chalmers Manufacturing Company, Allis-Chalmers provided a revised unit block on September 16, 1963 on their drawing P3833-BFS-1. This improved the dimensions of the draft tube, included wicket gates, and a speed increaser on the shaft before the generator. The manufacturer also provided performance curves for the proposed turbines and at a later date weights and costs of units. The centerline elevation of the hub of the water wheel was established at El -20.00. It is understood that this revised drawing meets the approval of all parties concerned.

Structural analysis of the units indicated the necessity for increasing the thickness of the sidewalls of the lower end of the draft tube to 6'-0". The indicated thickness was $2\frac{1}{2}$ feet, which would not be safe when a unit is unwatered. This change increases the unit spacing to 62'-0" in lieu of the 55'-0" shown in the Department of Interior report. The intake splitter must be 5'-0" wide in lieu of the 4'-0" scaled and should extend 1'-0" more toward the wheel. It appears that the wicket gates were added without any change in the length of the intake waterway. The transition from rectangular to circular section is very short; It does not appear that any change in overall dimensions is necessary however.

The interior wall between the turbine and control and switchgear galleries has been moved to the downstream edge of the turbine cover plate. Otherwise the concrete thicknesses shown are retained but the operating deck could be somewhat lower.

The deck of the IJC Report powerhouse was at El. 27.0, because with the vertical turbine setting this was necessary. However, with the present inclined turbine the deck can be lowered to El. +20.0. This is above highest tide and wave runup. The powerhouse locations are protected from the open sea and there is a relatively short wind fetch toward them. There will be a parapet wall toward the intake and discharge channels to prevent spray from reaching the deck. The powerhouse sections are shown on drawing TP1-045.

Trash racks would be provided at the intake. Three sets of intake and draft tube gates would be provided. The leaves would be about 7'-0" high. One of the intake gates would be a wheeled type for operation against flowing water. Three gantry cranes are required, one 30-ton crane for intake gates and trash racks, one 100-ton crane for the turbine and the third a 100-ton crane for the generator, speed increaser, and draft-tube gates. It is proposed to inclose the gantry cranes for the generator and turbine bays to permit work in the bays without exposure to weather. Since there are 50 units in each powerhouse and it is probable two units would be down for repair at one time, it would appear that two sets of cranes are required. The Department of Interior Report showed a grouping of 10 units with a 55'-0" bay for service and transformers between each 10-unit group. This scheme is being followed and it is planned to use these intermediate bays for maximum amount of service and maintenance with an erection unit at each end of the powerhouses about 83'-0" long, unless further studies indicate more space is required for the end bays.

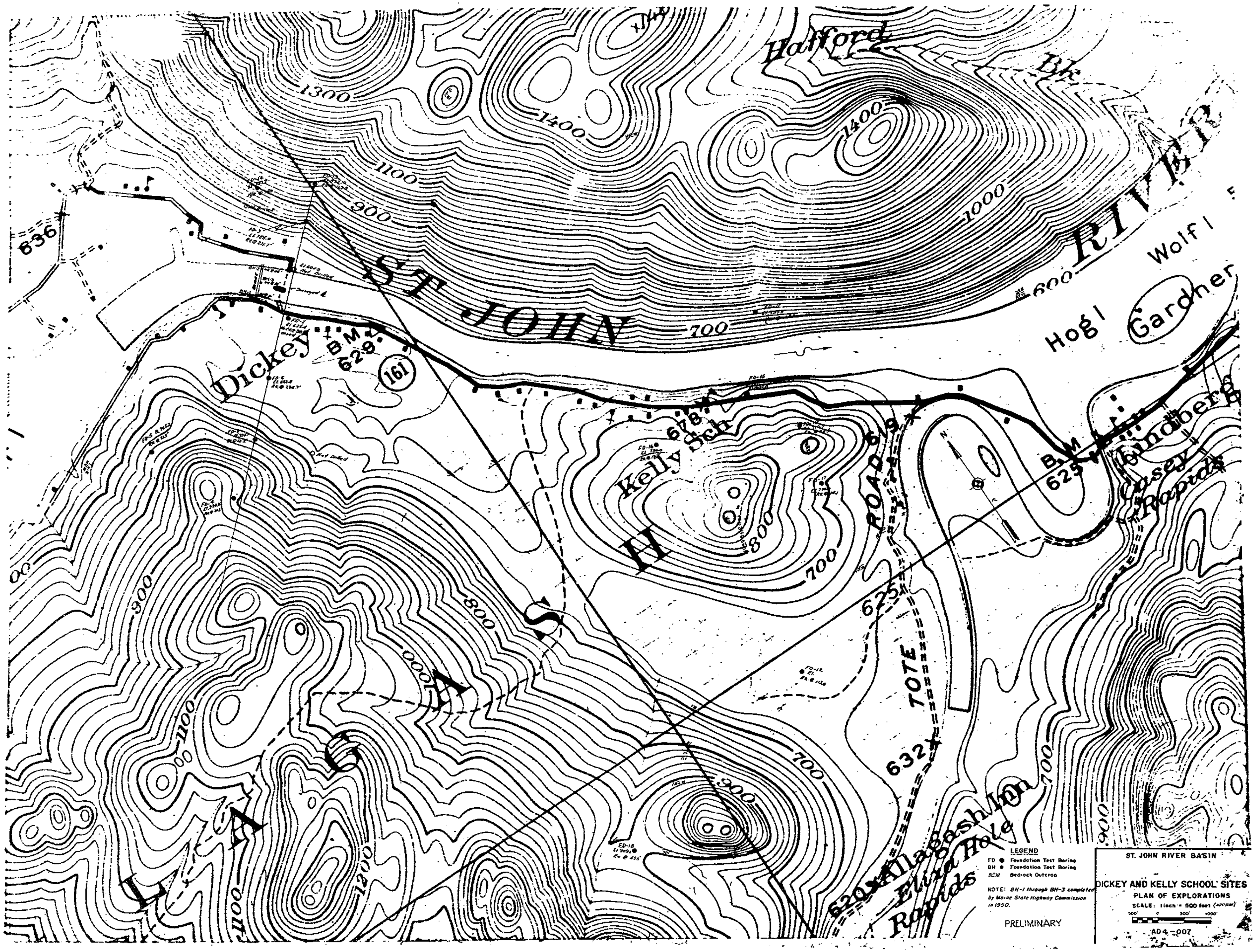
A transformer will be provided for each generator group of ten. Voltage will be stepped up to 345 and 230 kv, respectively, for the transmission lines to the United States and Canada. Take-off will be overhead to a common switchyard for the two powerhouses. It is understood that the switchyards will be laid out by the Department of Interior. The switching arrangement to be used should be finalized at an early date and results made known to NED.

The dimensions for each powerhouse are (62 x 50) + (4 x 55') + (2 x 83') = 3488 ft long by 188 ft wide. The channels are therefore 3320' wide at the powerhouse.

In preparing a plan for powerhouses at Eastport, Maine it is necessary to consider fishways for anadromous fish, such as Eastern salmon, shad and alewives. The IJC report includes a fishway around the tidal power plant as approved by the International Passamaquoddy Fisheries Board. A fishway should be built around each end of each powerhouse and a minimum sized attraction gallery be added over the draft tube as shown on drawing TP 1-045.

ATTACHED DRAWINGS

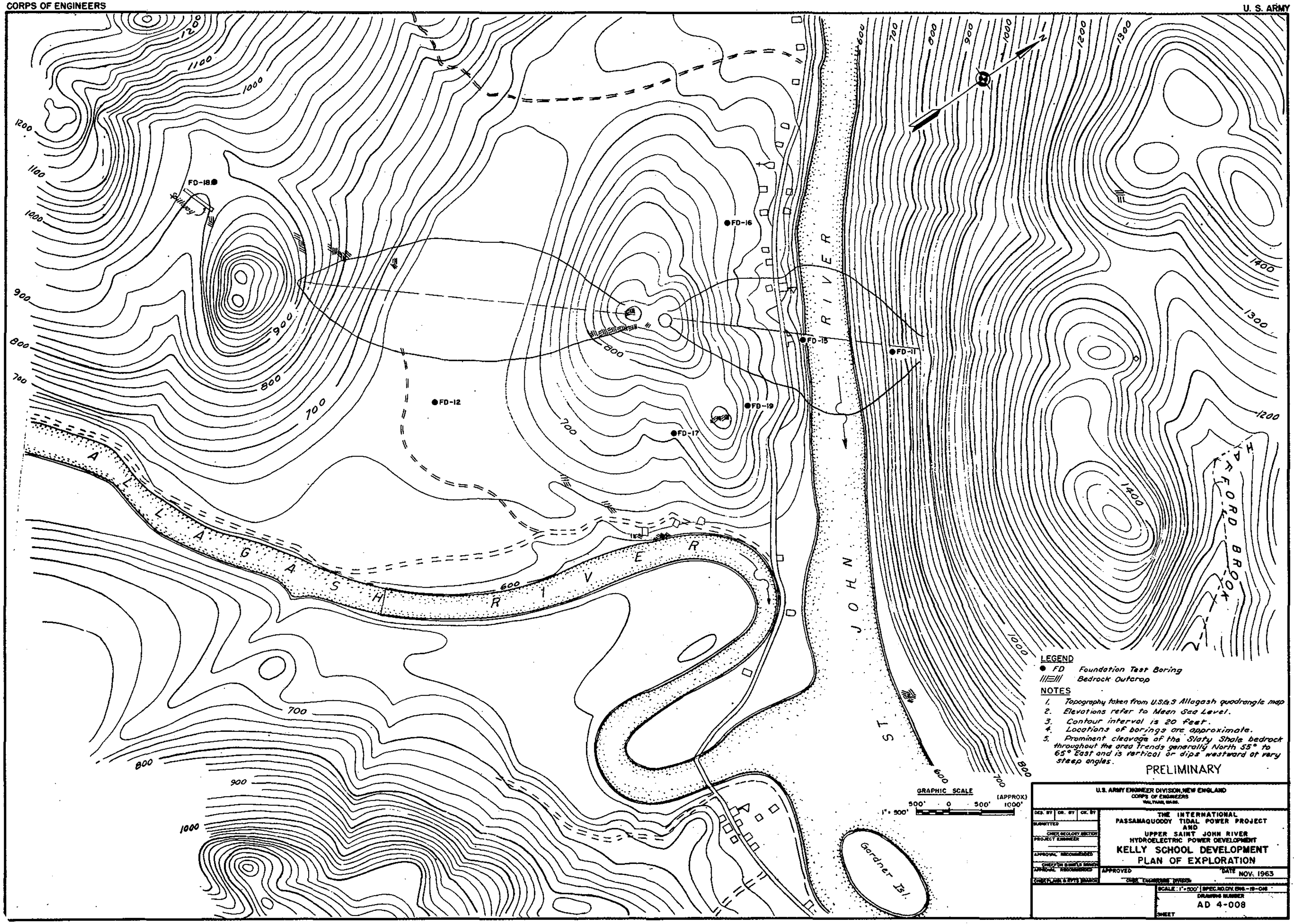
AD4-007	Dickey & Kelly School Sites	- Plan of Exploration
AD4-008	Kelly School Development	- Plan of Exploration
AD4-009	Kelly School Development	- Geologic Sections
AD4-010	Dickey Development	- Geologic Sections
AD2-239	Kelly School Development	- General Plan
TP2-062	Tidal Power Development	- Powerhouse No. 1 and No. 2 -General Plan
TP1-045	Tidal Power Development	- Powerhouse -Plan, Elev, Sec.



ST JOHN RIVER
Dickey
B.M. 628
161
Kelly Sch
Hafford Bk
Wolf I
Hog I
Gardner
Lindberg
Casey Rapids
B.M. 625
TOTE ROAD
Allagash Inn
Eliza Hole Rapids
ALLAGASH
LEGEND
FD ● Foundation Test Boring
BH ● Foundation Test Boring
Bedrock Outcrop
NOTE: BH-1 through BH-3 completed by Maine State Highway Commission in 1950.
PRELIMINARY
ST. JOHN RIVER BASIN
DICKEY AND KELLY SCHOOL SITES
PLAN OF EXPLORATIONS
SCALE: 1 inch = 500 feet (APPROX)
AD4-007

CORPS OF ENGINEERS

U. S. ARMY



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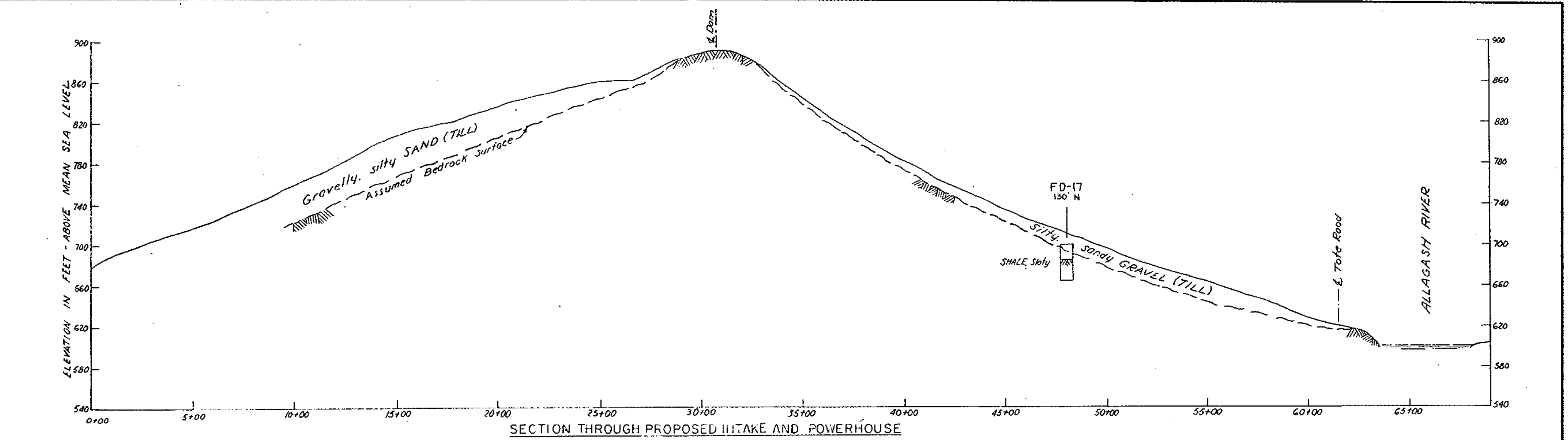
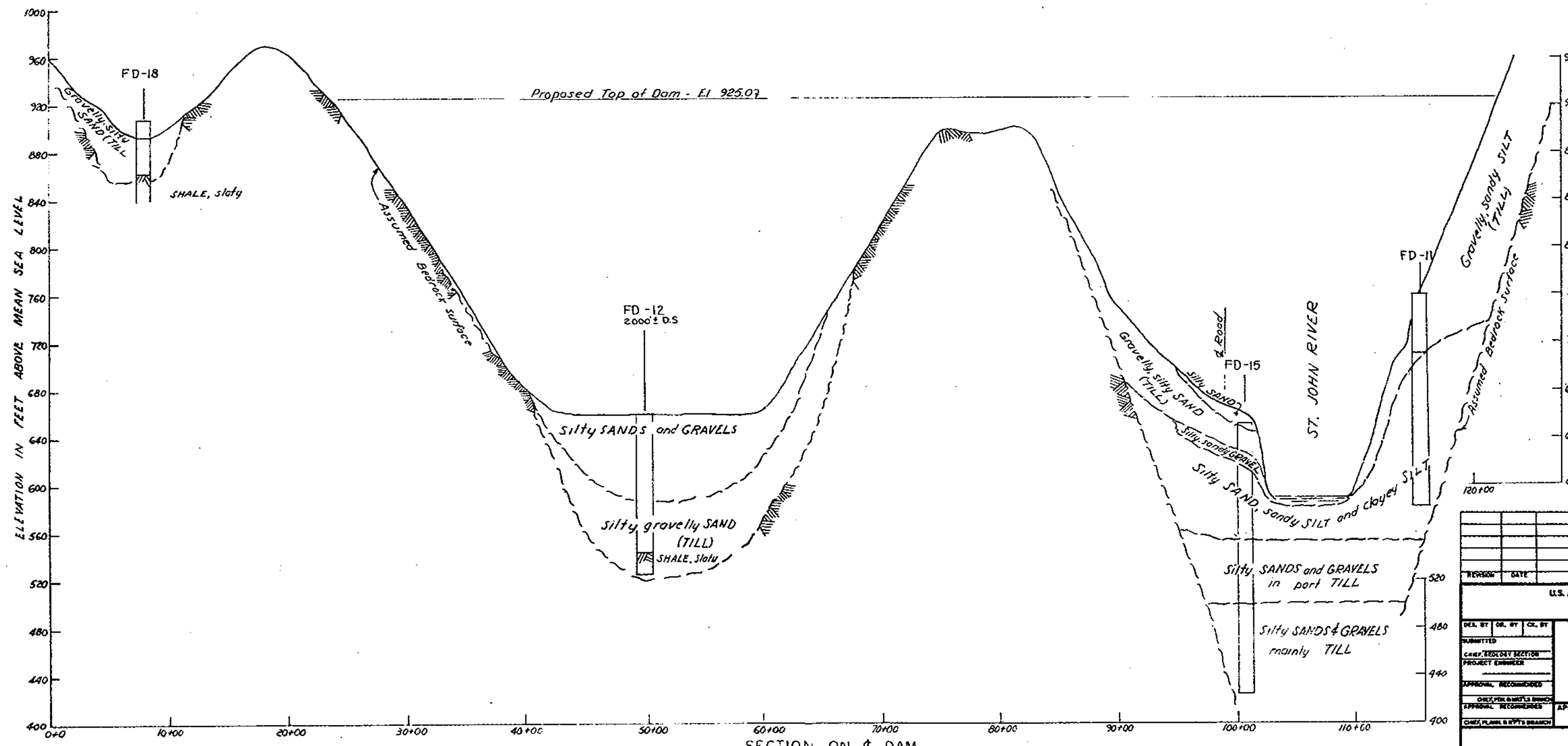


SECTION THROUGH PROPOSED INTAKE AND POWERHOUSE



SECTION ON ℄ DAM

(LOOKING UPSTREAM)

NOTES

Profiles taken from U.S.G.S. Allagash quadrangle map.

PRELIMINARY

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY | DR. BY | CK. BY

SUBMITTED

CHIEF, GEOLOGY SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, FDN. & MAT'LS BRANCH

APPROVAL RECOMMENDED

CHIEF, PLANN. & RPTS BRANCH

THE INTERNATIONAL
PASSAMAQUODDY TIDAL POWER PROJECT
AND
UPPER SAINT JOHN RIVER
HYDROELECTRIC POWER DEVELOPMENT

KELLY SCHOOL DEVELOPMENT
GEOLOGIC SECTIONS

APPROVED

CHIEF, ENGINEERING DIVISION

DATE NOV. 1963

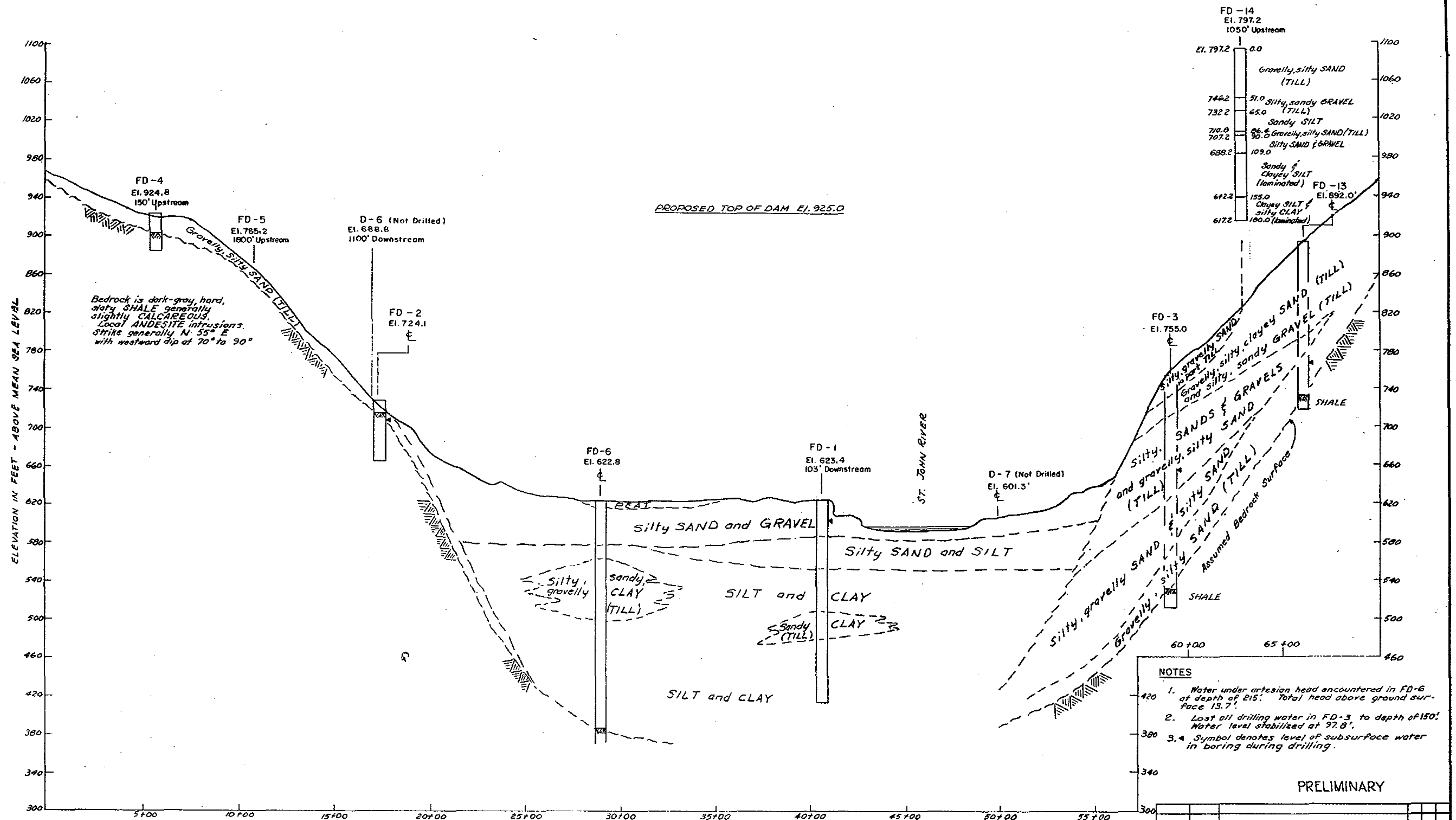
SCALE | SPEC. NO CIV. ENG.-19-016

DRAWING NUMBER

AD 4 - 009

SHEET

CORPS OF ENGINEERS U. S. ARMY



NOTES

1. Water under artesian head encountered in FD-6 at depth of 215'. Total head above ground surface 13.7'.
2. Lost all drilling water in FD-3 to depth of 150'. Water level stabilized at 97.8'.
3. ◄ Symbol denotes level of subsurface water in boring during drilling.

PRELIMINARY

SECTION ALONG SURVEY BASELINE

LOOKING UPSTREAM

REVISION	DATE	DESCRIPTION	BY

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WALTHAM, MASS

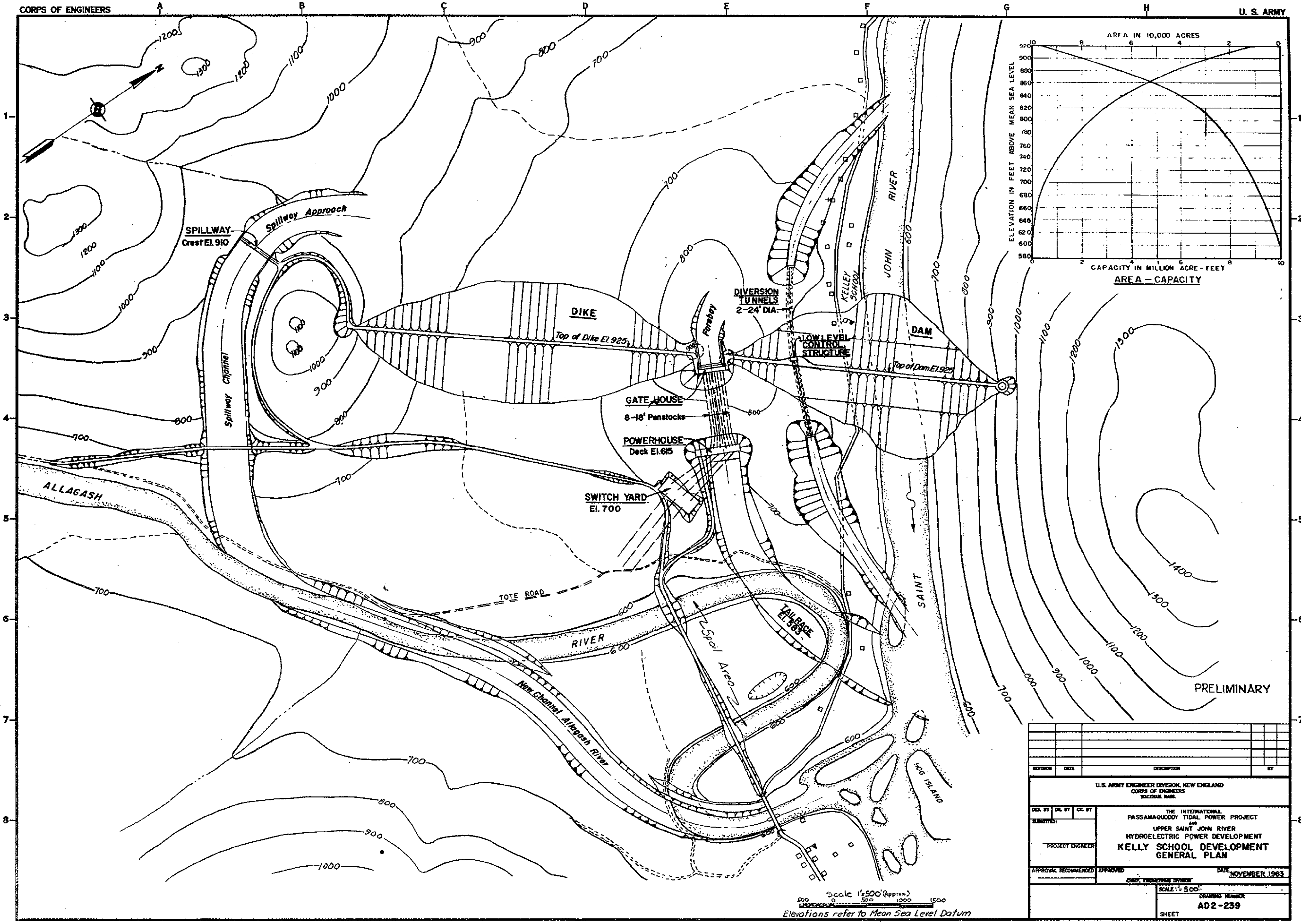
DES. BY | DR. BY | CK. BY

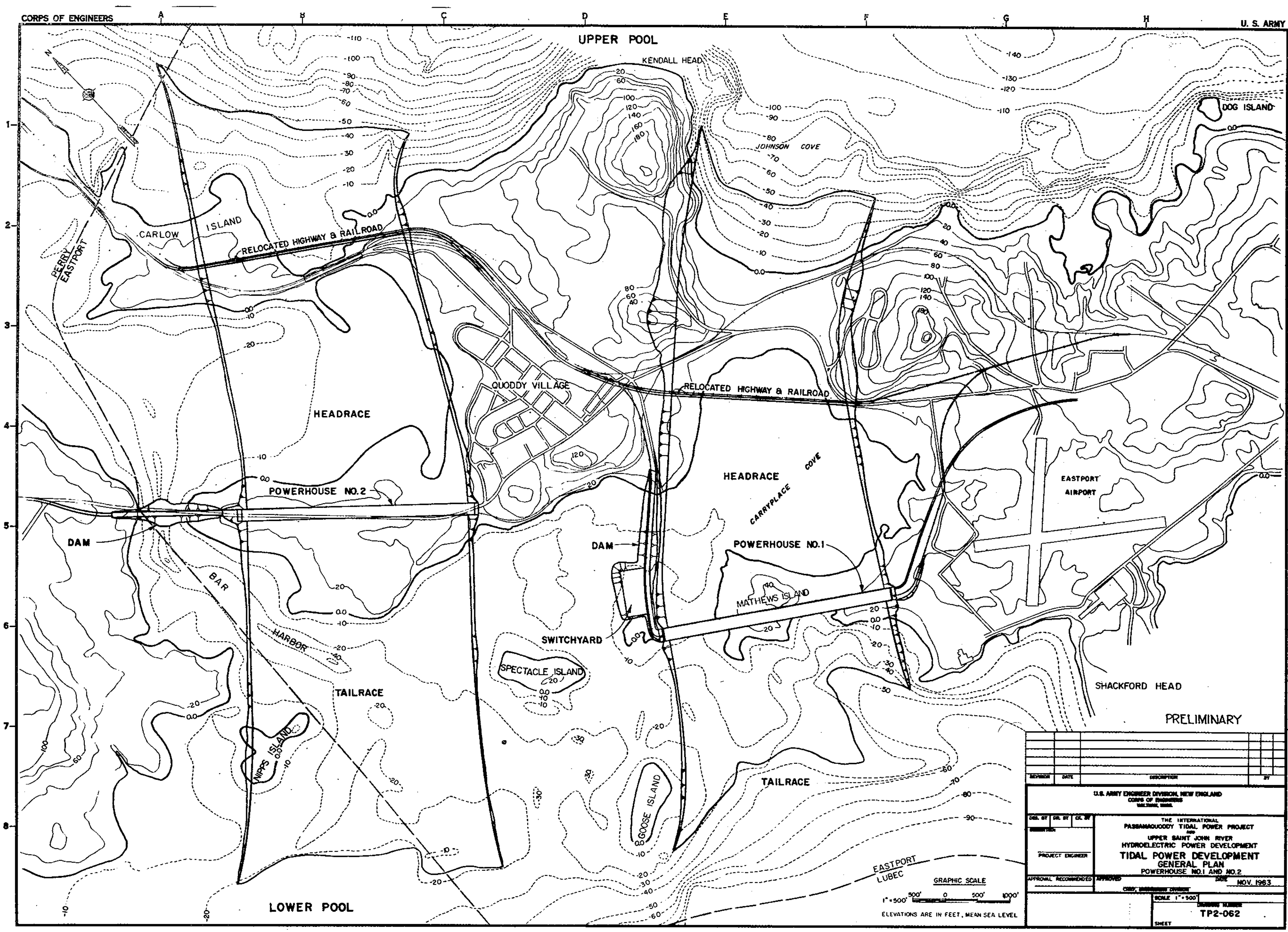
SUBMITTED
CHIEF, GEOLOGY SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, FDN. & MAT'LS BRANCH
APPROVAL RECOMMENDED
CHIEF, PLAN. & RPTS BRANCH

THE INTERNATIONAL
PASSAMAQUODDY TIDAL POWER PROJECT
AND
UPPER SAINT JOHN RIVER
HYDROELECTRIC POWER DEVELOPMENT
DICKEY DEVELOPMENT
GEOLOGIC SECTION

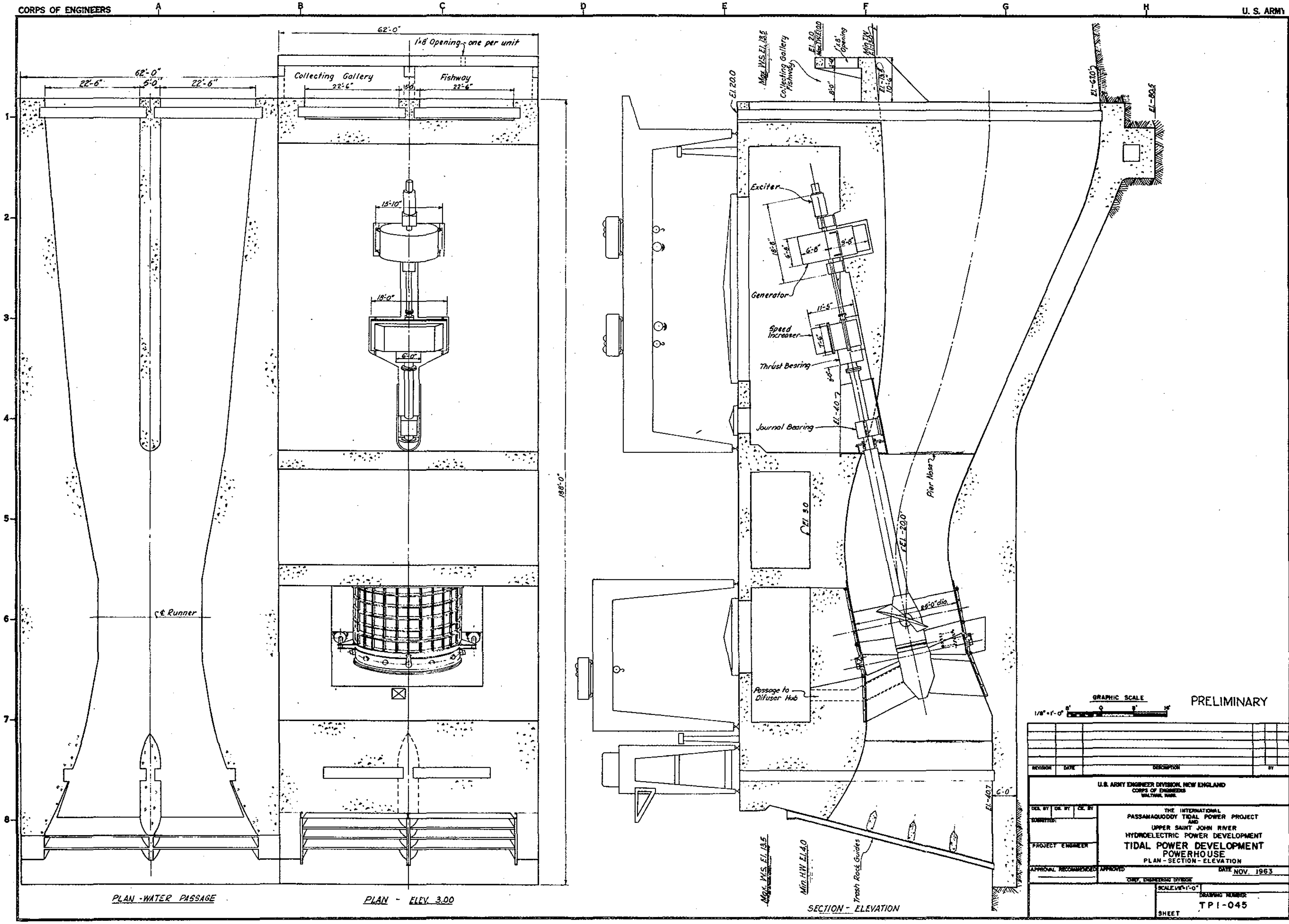
APPROVED
CHIEF, ENGINEERING DIVISION
DATE NOV 1963

SCALE
SPEC. NO CIV. ENG.-19-016
DRAWING NUMBER
AD 4-010
SHEET


CORPS OF ENGINEERS
U. S. ARMY
AREA IN 10,000 ACRES
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
CAPACITY IN MILLION ACRE-FEET
AREA – CAPACITY
SPILLWAY
Crest El. 910
Spillway Approach
Spillway Channel
DIKE
Top of Dike El. 925
Forebay
DIVERSION TUNNELS
2-24' DIA.
LOW LEVEL CONTROL STRUCTURE
DAM
Top of Dam El. 925
GATE HOUSE
8-18' Penstocks
POWERHOUSE
Deck El. 615
SWITCH YARD
El. 700
TAILRACE
El. 583
Spoil Area
TOTE ROAD
RIVER
ALLAGASH
New Channel Allagash River
KELLEY SCHOOL
SAINT JOHN RIVER
HOG ISLAND
PRELIMINARY
Scale 1"=500' (Approx.)
Elevations refer to Mean Sea Level Datum
REVISION
DATE
DESCRIPTION
BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
DES. BY
DR. BY
CK. BY
SUBMITTED:
PROJECT ENGINEER
THE INTERNATIONAL
PASSAMAQUODDY TIDAL POWER PROJECT
AND
UPPER SAINT JOHN RIVER
HYDROELECTRIC POWER DEVELOPMENT
KELLY SCHOOL DEVELOPMENT
GENERAL PLAN
APPROVAL RECOMMENDED
APPROVED
CHIEF, ENGINEERING DIVISION
DATE NOVEMBER 1963
SCALE 1"=500'
DRAWING NUMBER
AD2-239
SHEET



CORPS OF ENGINEERS
U. S. ARMY
UPPER POOL
KENDALL HEAD
DOG ISLAND
JOHNSON COVE
CARLOW ISLAND
RELOCATED HIGHWAY & RAILROAD
PERRY
EASTPORT
QUODDY VILLAGE
HEADRACE
POWERHOUSE NO. 2
DAM
BAR
HARBOR
TAILRACE
NIPPS ISLAND
SPECTACLE ISLAND
SWITCHYARD
GOOSE ISLAND
CARRYPLACE COVE
POWERHOUSE NO. 1
MATHEWS ISLAND
EASTPORT AIRPORT
SHACKFORD HEAD
EASTPORT
LUBEC
LOWER POOL
GRAPHIC SCALE
1" = 500'
ELEVATIONS ARE IN FEET, MEAN SEA LEVEL
PRELIMINARY
REVISION
DATE
DESCRIPTION
BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
DES. BY
DR. BY
CK. BY
PROJECT ENGINEER
THE INTERNATIONAL
PASSAMAQUODDY TIDAL POWER PROJECT
AND
UPPER SAINT JOHN RIVER
HYDROELECTRIC POWER DEVELOPMENT
TIDAL POWER DEVELOPMENT
GENERAL PLAN
POWERHOUSE NO. 1 AND NO. 2
APPROVAL RECOMMENDED
APPROVED
DATE NOV. 1963
SCALE 1" = 500'
DRAWING NUMBER
TP2-062
SHEET


CORPS OF ENGINEERS
U. S. ARMY
62'-0"
22'-6"
5'-0"
1'x8' Opening - one per unit
Collecting Gallery
Fishway
15'-10"
19'-0"
6'-0"
188'-0"
℄ Runner
El 20.0
Max W.S. El 13.5
Collecting Gallery Fishway
El 20
Max T.W. El 20.0
1'x8' Opening
Min T.W.
8'-0"
El -67.0
El -80.5
Exciter
Generator
Speed Increaser
Thrust Bearing
Journal Bearing
El -4.0
Pier Nose
℄ El 3.0
℄ El -20.0
25'-0" dia.
Passage to Diffuser Hub
6'-0"
Max W.S. El 13.5
Min HW El 14.0
Trash Rack Guides
PLAN - WATER PASSAGE
PLAN - ELEV. 3.00
SECTION - ELEVATION
GRAPHIC SCALE
1/8" = 1'-0"
PRELIMINARY
REVISION
DATE
DESCRIPTION
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PASSAMAQUODDY TIDAL POWER PROJECT
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UPPER SAINT JOHN RIVER
HYDROELECTRIC POWER DEVELOPMENT
TIDAL POWER DEVELOPMENT
POWERHOUSE
PLAN - SECTION - ELEVATION
APPROVAL RECOMMENDED
APPROVED
DATE NOV. 1963
CHIEF, ENGINEERING DIVISION
SCALE 1/8"=1'-0"
DRAWING NUMBER
TP1-045
SHEET

A transformer will be provided for each generator group of ten. Voltage will be stepped up to 345 and 230 kv, respectively, for the transmission lines to the United States and Canada. Take-off will be overhead to a common switchyard for the two powerhouses. It is understood that the switchyards will be laid out by the Department of Interior. The switching arrangement to be used should be finalized at an early date and results made known to NED.

The dimensions for each powerhouse are (62 x 50) + (4 x 55') + (2 x 83') = 3488 ft long by 188 ft wide. The channels are therefore 3320' wide at the powerhouse.

In preparing a plan for powerhouses at Eastport, Maine it is necessary to consider fishways for anadromous fish, such as Eastern salmon, shad and alewives. The IJC report includes a fishway around the tidal power plant as approved by the International Passamaquoddy Fisheries Board. A fishway should be built around each end of each powerhouse and a minimum sized attraction gallery be added over the draft tube as shown on drawing TP1-045.

COST ESTIMATES

General. A review is being made of the cost estimates of the Quoddy-Saint John River project, as reported to the International Joint Commission in 1958-1959, in order to up-date these costs on a more realistic basis. This review includes labor rates, equipment costs, materials and supplies, and mark-up of contractor's overhead and profit, and of contingencies.

Also included in this review are the productive rates for various classes of equipment, especially material handling equipment, in order to refine the cost estimates more realistically and to take advantage of advances in equipment design which allow for more economical operation.

Labor Rates. On Federal projects the minimum labor rates must be the prevailing rate of wates in the areas as established by the Secretary of Labor, which rates are not issued until contracts are ready for public bidding. It is, therefore, the duty of the study group to assess such rates and/or the rates the contractors would be required to use even though they may be higher than the prevailing rates.

Listed below are various sets of rates in key positions as were used in the 1958-59 report; as have been established by the Secretary of Labor under small-sized contracts in Maine for the years 1961-63; as are being used for major projects in the New Brunswick, Canada area; and as are proposed for use as of January 1, 1964 for the present report.

In regard to the Canadian rates, it should be noted that power plant structures in Canada cost about 25 percent less than similar structures in the United States. This was borne out on the Barnhart power plant on the St. Lawrence River where the Canadian half as administered by the Canadians cost 27 percent less than the American half as administered by the Americans.

How a treaty with Canada will resolve this matter with regard to Quoddy is not known at the present time. It must, therefore, be assumed that the whole project will be administered by the Americans and that realistic American labor rates will apply. If it were to be later decided that the Canadians would administer the construction of the Canadian part of Quoddy, it is believed that a saving of up to 25 percent could be assured for their part, which is roughly estimated to cost $200 million.

	Quoddy 1958-59 Report	Prevailing Rate-Small Maine Projects	Realistic Canadian Rates	Proposed Rates for Present Use
Carpenters	2.75	2.00-2.50	2.08	2.75
Laborers	1.85	1.31-1.50	1.18	2.00
Crane & Shovel Op.	3.50	2.30-3.03	2.00	5.10
Truck Drivers	1.90	1.45-1.50	-	2.20
Reinforcing Men	3.15	2.00	2.00	4.00
Dipper Dredge Op.	3.05	3.83	-	3.93
Deck Hands	2.05	2.64	-	2.74

It is believed that the rates listed in the last column are the ones that major American contractors would have to use even though lower prevailing rates were to be established.

Equipment Costs. One of the basic elements in a detailed cost estimate is the "rental rates" of construction equipment. While it is very unusual for contractors to rent equipment from third parties on large projects, yet these so-called "rental rates" are supposed to be the daily or monthly cost to a contractor of equipment owned or purchased by him. Two of the basic "Bibles" used for this purpose are titled "Contractors' Equipment Ownership Expense," published by the Associated Contractors of America (known as the "AGC" book); and "Compilation of Rental Rates for Construction Equipment," published by the Associated Equipment Distributors, known as the "green" book.

A review of the rental rates used in the 1958-59 report indicates that on the average these rates are higher than are in use today on large projects. The rates used in 58-59 were based on AGC ownership percentages, which percentages have proved to be unrealistic on major projects, as they are based on average conditions on small to medium sized contracts. The AGC book lists percentages only so it is necessary to obtain equipment costs in order to develop unit rental rates.

The "green" book is a more usable vehicle for this purpose as definite unit rental rates that a dealer would charge are listed for nearly every type of construction equipment except marine equipment. By a careful study of these rates, it has been found that deductions of up to 30 percent, depending on the size of a contract, prove a realistic basis for unit costs. For a project of the size of Quoddy, it is believed that unit rental rates based on this 30 percent deduction should be used.

Marine Equipment. Basic rental rates for marine equipment involve a more difficult study in practical construction engineering. While the AGC book shows unit percentages for such equipment, it has been found that these are based on enormous depreciation schedules based namely on an 8 to 12-year life instead of a 20 to 30-year life as is well known in the industry and which is used on cost estimates for government dredging projects. A schedule of unit rates for this equipment has been prepared, based on the longer-life concept, and has been found to average more than one-third less than the units used in the 1958-59 report. These units have been checked by a major marine contractor as being sensible and practical.

Sample of Marine Equipment Ownership Rates - 24-hr. day

	Quoddy 1958-59 Report	Proposed Rates for Present Use
10 cy Clamshell Dredge	$2,500.	$1,000
15 cy Dipper "	4,584	2,500
28-in Hydraulic "	5,000	3,000
1000 hp Towboat	780	400
1500 cy Dump Scow	817	250

Equipment Fuel and Lube Costs. Included in basic construction costs are fuel and lubrication costs of the various pieces of equipment. These costs are included under the item of "Materials and Supplies" in cost estimates. In a review of the 1958-59 report it has been found that in addition to the fuel and lube costs there has been included an item for "field repairs" amounting to 10 percent of the unit rental rates of equipment. This item for "field repairs" has been found to be a duplication in costs as the cost of field repairs is included in the basic rental rates.

Cost Mark-ups. In the 1958-59 report the mark-ups used on basic costs to cover a contractor's overhead and profit were 17 percent and 10 percent. In a later review it was believed that these would be too high for large projects. A review by OCE suggested a reduction from 10 percent to $7\frac{1}{2}$ percent in the profit item but no change in the overhead percentage.

After costs were developed including the contractors' overhead and profit, the 1958-59 report included 15 percent for contingencies and 9 percent for engineering, design, supervision of construction, and administration. A later review again indicated that these percentages were too high to be realistic. This again was reviewed by OCE and they suggested that the contingency factor be applied not as an average percentage of the total project but by applying separate acceptable factors for the various major units of the project. This change was estimated by OCE to reduce the average of 15 percent to about 13 percent.

OCE recommended no reduction in the 9 percent for government overhead.

Estimate Trends. Preliminary studies of present-day costs for the project, as compared with the 1958-59 report, indicate reductions in unit costs of items where construction equipment costs are a major factor, such as in the excavation and transporting of earch and rock by land or marine equipment. Where materials and/or labor are major factors, the unit costs indicate equal or increased costs, depending on relationship of the various factors. This would include such items as concrete, metal work, and other minor material items.

ATTACHED DRAWINGS

AD4-007	Dickey & Kelly School Sites	- Plan of Exploration
AD4-008	Kelly School Development	- Plan of Exploration
AD4-009	Kelly School Development	- Geologic Sections
AD4-010	Dickey Development	- Geologic Sections
AD2-239	Kelly School Development	- General Plan
TP2-062	Tidal Power Development	- Powerhouse No. 1 and No. 2 -General Plan
TP1-045	Tidal Power Development	- Powerhouse -Plan, Elev, Sec.